MEAM 620 Project 1 Phase 4 Report

You have successfully brought together path planning and feedback control in real life to fly Crazyflies through our laboratory maze. To close out this project, we would like you to prepare a brief report reflecting on the system you developed and its performance.

1 Group Deliverables

Your group will submit a report document and your code to the Gradescope group assignment.

1.1 Report

Each group should submit a brief report, four pages including plots. Submit a single PDF document. We have provided an optional Latex template for use in Overleaf[1], but it is not necessary to use Latex. Your report will be evaluated in terms of how well you clearly present your approach and interpret your observations. The report should contain the following information:

1.1.1 System Overview (20 points)

Introduce the project goals and experimental system.

- What was the objective of the lab? What robot capabilities have you demonstrated?
- What hardware is being used? Which devices are doing sensing, computation, and control?
- What information is being sent to the robot?

1.1.2 Controller (25 points)

Describe the implementation and performance of your tracking controller.

- Describe your position controller with equations.
- Provide your control gains with units, and interpret the roll of k_p and k_d.
- Explain why your attitude controller is not being used, and what is happening instead.
- Were any adjustments required to account for differences between simulation and experiment? What are plausible reasons for these differences, if any?
- Discuss your controller performance in terms of steady state error, damping ratio, rise time, and settling time. Provide one plot of position over time clearly illustrating these characteristics from any one of your experiments. A brief section of one of your first session trajectory experiments may be a good choice.

1.1.3 Trajectory Generator (25 points)

Describe the implementation and performance of your trajectory generator.

- How did you select waypoints?
- How was time allocated between waypoints?
- Describe your trajectory generator with equations.
- Discuss the smoothness/feasibility of your planned trajectory. Illustrate with a plot over time of position, velocity, and any other interesting derivatives from any one of your experiments.

[1] https://www.overleaf.com/read/cnhnfyrctgkp

1.1.4 Maze Flight Experiments (30 points)

Report your experimental results flying the maze using your planner, trajectory generator, and controller.

- For each of the three maze runs provide a 3D plot showing the world obstacles, waypoints, planned trajectory, and actual flight path.
- For one maze trial show position and velocity vs time for your actual flight.
- How large were your tracking errors? How could you use this information to plan safe trajectories?
- Could your trajectories have been more aggressive?
- What changes could you make to improve the speed or reliability of your system in the maze?
- If you had one more session in lab to do something interesting, what would you want to try?

All reported quantities must have units, and all plot axes must have labels.

1.2 Code

Create a .zip file of all the code your team used for this lab. Submit to Gradescope along with your report.

2 Individual Deliverable

Each person should submit a one-paragraph description of what they personally did for the group, and a short description of the contributions of their teammates. Include your name and group number. Submit this document to the Gradescope individual assignment.

3 Data and Plotting

Your experimental results were saved in .bag data files. We have provided a starter script to read data out of your bag and create some example plots. Using these examples as a starting point, you will be able to create any other plots you need. All reported quantities must have units, and all plot axes must have labels. To keep your plots interpretable, you should not plot excessive data before your trajectories begin or after they finish.

Reading the bag files will require installing an additional package. This can be installed via a terminal inside your virtual environment as follows:

```
pip install --extra-index-url https://upennmeam620.github.io rosbag
```